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Room Temperature Creation of High Mobility Two-Dimensional Electron Gases at Complex Oxide Interfaces

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The progress in atomic scale control of complex oxide film growth has resulted in the discoveries of a quasi-two-dimensional electron gas (q2DEG) at the heterointerface between two band-gap insulators of perovskite $LaAlO_3$ (LAO) and $SrTiO_3$ (STO),[1] and more recently, a 2DEG with extremely high carrier mobilities, exceeding 100,000 $cm^2V^{-1}s^{-1}$ at 2 K, at a novel spinel/perovskite interface between gamma-alumina (γ-Al_2O_3) and STO (GAO/STO).[2] These complex oxide 2DEGs provide opportunities for a new generation of all-oxide electronic devices.[3,4] Here, we present firstly the room temperature creation of oxide 2DEGs at the epitaxial spinel/perovskite GAO/STO heterointerface.[5] The GAO films can be epitaxially grown on TiO_2-terminated STO with a well-controlled sub-unit cell layer by layer mode at room temperature. This GAO/STO heterointerface shows a suppressed redox reaction compared to the disordered-LAO/STO (*d*-LAO/STO) heterointerfaces grown under similar conditions.[6] While it shows electron mobilities exceeding 3000 $cm^2V^{-1}s^{-1}$ at 2 K, which is 5-10 times higher than the mobilities of *d*-LAO/STO. Secondly, based on the above finding, we will present how a buffer layer can suppress the redox reactions and enhance the carrier mobility at buffered *d*-LAO/STO interfaces. This provides new opportunities for oxide electronics.

[1] A. Ohtomo, H. Y. Hwang, *Nature* **427**, 423 (2004).
[2] Y. Z. Chen *et al.*, *Nat. Commun.* **4:1371** doi: 10.1038/ncomms2394 (2013).
[3] J. Mannhart, D. G. Schlom, *Science* **327**, 1607 (2010).
[4] F. Miletto Granozio, G. Koster, G. Rijnders, *MRS Bullettin* **38**, 1017 (2013).
[5] Y. Z. Chen *et al.*, *Adv. Mater.* **26**, 1462 (2014)
[6] Y. Z. Chen *et al.*, *Nano Lett.* **11**, 3774 (2011).